

# Synthesis and Characterization of Self-assembled Nanoscale Magnetic Particles

D. Kumar, North Carolina A & T State University, DMR-0303552

Shape and crystal anisotropy play an important role in determining the magnetic properties of most fine particles. According to our initial results, the change in shape and crystal orientation of nanoparticles can be easily maneuvered by changing the thin film matrix in which nanoparticles are being embedded. For example, our previous studies have shown that most of the Ni nanoparticles are spherical in thin film alumina matrix. But the shape is completely different if the matrix is changed to TiN (Fig. 1). It is clearly seen in this figure that nickel islands are faceted with a truncated pyramidal shape. Fig. 2 is a  $\langle 011 \rangle$  zone axis high-resolution image of a nickel island with the inset showing a cross-sectional selected area electron diffraction pattern taken from areas containing silicon, titanium nitride and nickel. The alignment of diffraction spots of Si, TiN and Ni indicates that the predominant epitaxial orientation for both TiN and Ni is “cube-on-cube”, that is all three (100) axes of film are parallel to those of silicon substrate. The magnetic studies on these samples are in progress.

A manuscript containing this work is being prepared for Journal of Applied Physics.

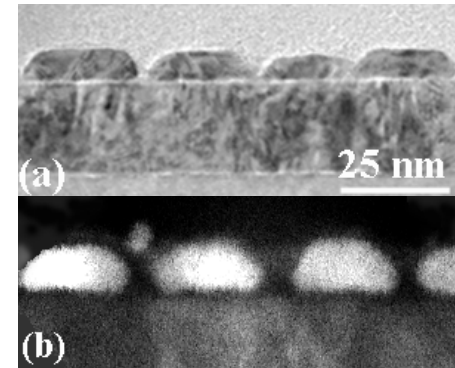


Fig. 1. Images of truncated pyramidal shaped nickel islands: (a) low-magnification TEM, and (b) STEM Z-contrast image.

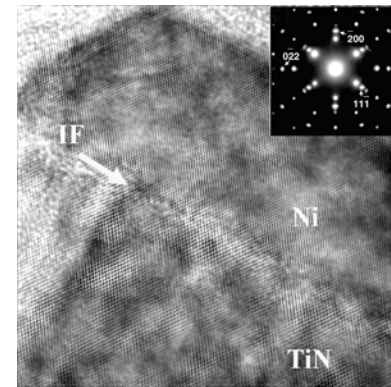


Fig. 2. HRTEM image of an oriented nickel island. The inset is a cross-sectional electron diffraction pattern.

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## Education:

Since this NER funding is only for one year, the PI is involving only one graduate (Ms. S. Dana, Department of Mechanical and Chemical Engineering) and one undergraduate student (Mr. Roscoe Charity, Department of Electrical Engineering). The master student is expected to complete her entire thesis work with the funding available from this project.



## Outreach:

### Undergraduate students

The PI had arranged a pulsed laser deposition (PLD) training session of one week for more than 10 undergraduate students in the college of engineering. These Students had opportunity to learn about PLD assisted fabrication of self-assembled nanomagnetic particles in thin film matrix.

### K-12 interaction

The PI had given a couple of lectures to high school science teachers participating in a two-week NIA workshops (see the adjacent picture), held in the NCAT campus during the Summer 2003. The teachers had direct opportunities to see some of the advanced instrumentations for the fabrication (PLD) and characterization (SEM, AFM, Nanoindentation, etc) of nanophase materials.